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CONSTRUCTION

LARGE-PANEL, MULTI-STORY CONSTRUCTION IN SIBERIA DISCUSSED

Moscow NA STROYKAKH ROSSII in Russian No 4, Apr 82 (signed to press 25 Mar 82) pp 4-7

/Article by Yu. Kuzin, candidate of architecture and director of SibNIIZP: "Erection of Large-Panel Buildings in Siberia

/Text/ The implementation of the grandiose programs outlined during the 26th CPSU Congress for developing the eastern regions of the country, which possess rich natural resources and at the same time are characterized by complicated and unfavorable climatic conditions (low temperatures, permafrost, prolonged winter period and seismic disturbances), and the build-up in the industrial potential of these regions have increased the flow of the population to these areas and have attached greater importance to the problems concerned with accelerating and achieving qualitative improvements in mass civil housing construction.

Concern for man and the proper distribution of productive forces throughout the country require the creation of good living conditions in the eastern regions of the country, conditions which include not only providing modern and good quality housing that conforms to the local climatic conditions, but also organizing a rich environment for living in the broad sense -- in particular, ensuring completeness and artistic expression in a building system. In short, the planners, builders, architects and construction industry workers must do everything possible to ensure the creation of maximum conveniences and comforts for workers in this stern region and satisfy their aesthetic needs. This will create a true foundation for smoothing out the "social differences from a territorial standpoint," the need for which was emphasized during the 26th CPSU Congress by Comrade L.I. Brezhnev.

The most progressive type of mass civil housing construction in the eastern part of the country, similar also to many other regions -- is that of large-panel housing construction. Its proportion is rather high in individual cities (in Surgut, for example, it is 91 percent, in Nizhnevartovsk -- 82.4 percent and in Nefteyugansk -- 79.7 percent), but on the whole it is insufficient and fluctuates in the neighborhood of 50 percent. Only a limited amount of work is being carried out in connection with converting KPD /plant for large-panel

housing construction/ enterprises over to the production of dwellings using plans for new series. As a result, in Siberia for example, only 57 percent of the capabilities of 85 housing construction enterprises here are oriented towards the construction of buildings using standard plans for new series.

There are a number of acute problems: improving the design solutions for apartment houses (in particular, raising the heat-retention qualities of enclosing structures, improving the butt joints of panels and so forth), optimizing their architectural-planning solutions, developing the production base of the construction industry, reducing labor expenditures for the production and installation of building elements and achieving economies in the use of material and labor resources. An urgent solution must be found for the tasks concerned with erecting public buildings.

The Novosibirsk all-union conference entitled: "Improvements in Large-Panel Housing Construction in Siberia," convened in late 1981 by USSR Gosstroy, Gosgrazhdanstroy /State Civil Construction/ and the NTO /Scientific-Technical Department/ for the construction industry was devoted to some of the more urgent problems associated with the development of mass civil housing construction in the eastern part of the country. During this conference, a thorough analysis was provided on the experience accumulated in industrial civil housing construction and the principal trends for developing it and the specific measures for improving prefabricated housing construction were outlined.

In this article we are publishing a selection of materials concerning this conference, materials in which the fruitful work of the planning institutes and other organizations in the sphere of improving Siberian housing construction is reflected and a number of basic problems requiring decisions by the directive organs are raised.

The program for further growth in the industrial potential of the Siberian region is inseparable associated with the successful implementation of a long term program for civil-housing construction.

At the present time, 70 percent of the overall volumes of housing construction in cities and 5-10 percent in rural populated points are being carried out using large-panels. Construction experience in Siberia reveals a high level of effectiveness for large-panel housing construction, which made it possible over the past 20 years to raise the level of availability of housing to the population by almost twofold and to realize a savings in capital investments of 627 million rubles and a reduction in labor expenditures of 68.4 million man-days compared to the erection of brick buildings.

In recent years, a considerable increase has taken place in the average amount of space made available for one resident. The proportion of 3, 4 and 5-story buildings has decreased. An analysis of cost data reveals that large-panel 9-story apartment houses are the most economical form of housing for Siberia. Stable growth has been observed over the past few years in the number of apartments

being provided with all types of engineering equipment (including hot water supply). In 1981 the proportion of such apartments in the western Siberia and eastern Siberia regions amounted to an average of approximately 80 percent.

Approximately one half of the capabilities of large-panel housing construction enterprises in Siberia have already converted over or are in the process of converting over to the production of new series of apartment houses. Series 111-97 is being employed most extensively; it is being introduced into operations at 26 KPD plants, the overall capability of which is 52.5 percent. Other enterprises are converting over to the use of the series 111-90, 121, 112, 75, 142, 83, 125, 135 and 72.

A structural analysis of the industrial base of Siberia reveals that small plants having a capability of up to 50,000 square meters of overall space annually, or 6.8 percent of the overall capability, constitute 25 percent of the base; 17.6 percent of the overall capability is accounted for by medium-size plants (50,000-100,000 square meters of overall space annually), the number of which is equal to 25 percent of the overall number of enterprises; 75.6 percent of the overall capability is accounted for by large enterprises, the proportion of which in terms of number of enterprises is 50 percent. Many Siberian cities are characterized by a group (2 or more) distribution for large-panel housing construction enterprises. The proportion of such enterprises in terms of capability -- approximately 57 percent.

The flow line-unit and bench technologies are employed most extensively at active KPD enterprises, with the conveyer line technology being used for the production of 12 percent of the products.

Attention is being focused on the low coefficients of use of the capabilities of the base for industrial completely prefabricated housing construction. Thus, for western Siberia it equalled an average of 0.78; eastern Siberia -- 0.73. The highest indicator was achieved in Omskaya Oblast -- 1.0 (USSR Ministry of Industrial Construction); Novosibirskay Oblast --0.93 (USSR Ministry of Construction); Tomskaya Oblast -- 0.86 (USSR Ministry of Construction).

An analysis of the structure of the KPD base, in terms of the forms of production organization, reveals that housing construction combines constitute a considerable portion of the base: 47.3 percent, of which 27.5 percent is on an industrial balance.

The restoration of fixed capital at KPD enterprises, compared to new construction and taking the Siberian conditions into account, is effective since it is accompanied by the replacement or modification of the active portion of the fixed capital, as determined by the progressive nature of plant development.

With a rather high level of large-panel housing construction being achieved in the region, a troublesome area continues to be the architectural quality of city construction. True, the planners and builders have accomplished a great deal in this regard during the past few years. With the introduction of the new series for apartment houses, a conversion has been made over to the block-section method of planning. In some cities they have finally abandoned the dismal buildings of obsolete series. Buildings planned on the basis of the block-section method are

being erected. The architects now have at their disposal a means for achieving the best architectural-planning solutions for the building of microregions.

Combinations of common and frontal block-sections and those which rotate at various angles are making it possible to achieve organically composed structures which conform to the configurations of sectors of territory and to the local relief. Without a doubt, this represents a great achievement on the part of those architects and builders who are introducing new generations of apartment house series into operations. Has this produced the desired result? Unfortunately, only partially.

For example, the new Series 111-97 has been in use in Krasnoyarsk since 1971. Mention should necessarily be amde of the operational competence and business-like approach displayed by the builders during the modernization of the Korkino KPD plant. Seven block-sections were introduced during the first two years. During the next 2-3 years, housing construction was carried out using the complete nomenclature of block-sections, industrial buildings were erected having built-in and attached food and industrial goods stores and boarding houses for small families for 400-600 occupants were also built (in all, more than 20 types).

The erection of multi-level apartment houses commenced in 1976. The first 16-story building was placed in operation on the shore of the Yenisey River in 1979. This was obviously the result of a high level of responsibility and c scientiousness being displayed by the builders and it was also occasioned by the presence of well organized business contacts between the Krasnoyarsk builders, the planners of Krasnoyarskgrazhdanproyekt and the authors of the Series 111-97.

The apartments in the new series of dwellings are distinguished by a high level of comfort, a wide entrance area, large kitchen and a square overall room (4.5 X 4.5 square meters), with the rooms being separate for the most part. The

The planners of Krasnoyarskgrazhdanproyekt successfully placed these buildings, composed of various block-sections, in micro-regions having a complicated relief. However the external appearance of the overall building system leaves something to be desired owing to the monotonous architectural design of the facades. All of the buildings are finished off using the same type of coated slab, the same color and the same type of railings for the balconies, loges, entrance parapets and so forth.

What is the reason for this phenomenon? The fact of the matter is that the architects created diverse variations for the facades but they remained on paper only. They were never used in the production technological cycle. Rather paradoxical is the fact that, despite its relatively low capability, the enterprise has succeeded in mastering more than 600 types of products in order to be able to produce a complete nomenclature of block-sections and buildings, but it lacked the capability for producing 60-100 types of items which these buildings required.

This was obviously the result of our inability to plan satisfactorily the enterprises for completely prefabricated housing construction. Quite often we deliberately leave room in the technological allocation of elements for additional architectural members. This is done at times out of purely economic considerations, for the purpose of achieving higher technical-economic indicators.

Thus, in the planning for the KPD-140 plant at Bratsk, only six block-sections of the Series 97 were included in the technological allocation and absolutely no consideration was given to the need for additional block-sections or multi-level apartment houses, which this enterprise should have produced for the construction of the central portion of Ust'-Ilimsk and Bratsk. Naturally, today, with the mastering of items for individual multi-story buildings having commenced, the planned capabilities of the plant have decreased considerably, not to mention the difficulties being encountered in connection with the production of a broad nomenclature of architectural elements and items. And indeed all of this could have been taken into account earlier when developing the plan for the enterprise.

As already mentioned, an active process is underway in many Siberian cities aimed at modernizing enterprises for the production of more progressive series for apartment houses. In such situations, a most important condition for a qualitative change or for improvements in the architecture of large-panel buildings is that of maximum concentration, in a city or even in a particular region, of the plant capabilities required for producing only one specific series. Priority importance is attached here to the principles of element specialization and cooperation by enterprises, by means of which real opportunities appear for realizing qualitative improvements in the final product. With a considerable reduction in the overall number of types of items, an increase takes place in the production of different block-sections, apartment houses having built-in social and cultural-domestic enterprises, boarding houses and other types of buildings of varying floor levels. The opportunities are increasing for the architectural construction of buildings through growth in the proportion of additional members by means of which it is possible to achieve the desired diversity in the solutions for facades.

The mutual combining of numerous block-sections and apartment houses ensures positive solutions for the problems concerned with city construction maneuverability, which in turn makes it possible in planning to convert over to the principle of "from an item to a plan," that is, based upon a specific nomenclature for items produced to carry out individual housing construction while taking into account all of the requirements (architectural, climatic, demographic and so forth) of the particular region.

Thus the decision to modernize DSK-1 /house building combine/ and ZZhBI-1 /reinforced concrete and concrete products plant/ in Novosibirsk for the production of the same Series 97, with an overall capability for the enterprises of 700,000 square meters of overall area annually, is considered by us to be both timely and proper.

An analysis carried out by SibZNIIEP jointly with Glavnovosibirskstroy has shown that the indicated trend (element specialization and cooperation) will make it possible to reduce the nomenclature of items, raise labor productivity by almost 30 percent and increase the output of goods per square meter of production space by almost 1.5-2 times. In addition, it will lower production costs by 6-8 percent and it will improve the quality of the products considerably by transferring a definite portion of the finishing work from the construction site to plant conditions.

A great reserve for raising the effectiveness of large panel housing construction is that of improving the quality and diversity of the construction work, lowering the labor intensiveness and reducing the schedules for the erection of buildings

and this reserve can be utilized through the development of uniform construction (regional for Siberia) catalogs for the construction elements and structures. Work on the creation of such catalogs is only now beginning and it should be completed rapidly, since in the absence of such work it will be impossible to carry out the next stage in mass housing construction -- the conversion over to the system of "open standardization."

At the present time TsNIIEP zhilishcha /Central Scientific Research and Planning Institute of Standard and Experimental Planning for Housing/, jointly with other institutes (including ours), is developing a theme for the creation of an architectural-design-technological system for large-panel housing construction. This study will provide more detailed answers on the method for solving many vital problems concerned with further improving housing construction in Siberia.

The time is not far off when the dwellings built using third generation plans will have to yield to buildings of the next and more improved generation. This change should be completed by 1990. It is important for this conversion over to the construction of fourth generation housing to be carried out with minimal production losses.

In this regard, the institute has developed several experimental multi-story apartment houses taking into account the norms for the next stage. The design and architectural parameters of the Series 97 provide the foundation for this work. Experimental dwellings (one of which in accordance with the plans has a developed group of social and cultural-domestic facilities -- dwelling-complex) are now beginning to be erected in Krasnoyarsk. The principal goal of the experiment is that of finding a system which will make it possible to convert over from the solutions being employed for apartment houses during this present stage to buildings having a raised comfort level and to do so in a more flexible and painless manner.

This experiment confirms the viability of increased planning for a modular 1.5 X 1.5 meter network, on the basis of which the Series 111-97 was developed. Analysis reveals that when redesigning the Series 97 buildings, the norms for the subsequent stage require changes in only approximately 30 percent of the items. That is, the conversion of plants presently producing Series 97 over to buildings offering greater comfort can be carried out without any radical reorganization or modernization of the production base.

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SIBERIA: HOUSING CONSTRUCTION IN NORTHERN REGION

Moscow NA STROYKAKH ROSSII in Russian No 4, Apr 82 (signed to press 25 Mar 82) pp 7-11

/Article by A. Kotlovoy, chief engineer at Leningrad Scientific-Research Institute of Economics and Planning: "Mass Housing Construction in Northern Regions"/

/Text/ During the next decade, the development of cities in the northern and northeastern portions of the USSR will be characterized by a further increase in the volumes and rates of housing construction.

The plans call for the placing in operation of 33.9 million square meters of housing space, of which amount more than one half will be built in the far eastern portion of the northern USSR, that is, under exceptionally unfavorable natural conditions.

The task of providing comfortable housing for the growing population in these regions will make it possible to solve the personnel turnover problem, which in turn will create the conditions for more stable and efficient work by the enterprises.

Improvements in the quality of housing require considerable additional material and labor expenditures and it is difficult to make such expenditures in the sphere of construction in light of the deficit in materials and labor resources.

In this regard, priority importance is being attached to developing structural systems and elements for buildings which will ensure more effective utilization of materials and energy resources with minimal labor expenditures.

The principal design type of dwelling under construction at the present time in cities and settlements consists of completely prefabricated panel and frame-panel construction. Thus, during the period from 1975 to 1980, the proportion of completely prefabricated buildings, compared to the overall volume of housing construction, increased from 40 to 50 percent for the European and eastern Siberian northern regions. In the regions of west Siberian north, the proportion of completely prefabricated buildings during this period amounted to approximately 5-25 percent. The trend towards an increase in such buildings, compared to the overall volume of housing construction, continues.

Completely prefabricated public buildings are still not being employed extensively in the northern zone of the USSR and this is largely the result of the construction base not being properly prepared.

The industrial construction of dwellings and public buildings in the region under review constitutes a qualitatively new stage in city development in the northern territories, where such development is complicated by stern climatic conditions and the presence of permafrost and seismic disturbances.

LenZNIIEP /Leningrad Scientific-Research Institute of Economics and Planning/ has validated large-panel housing construction during this modern stage, from a scientific and technical-economic standpoint, as being the most progressive type of mass construction for ensuring high rates of growth in the housing fund and the construction of public buildings and also complete plant readiness of the products, which reduces sharply the overall labor expenditures and ensures high quality work.

Four principal series of large-panel dwellings, which take into account the diverse geological, seismic and climatic conditions, were developed by the institute.

The principal one for the Far North -- Series 112 with transverse supporting walls and different variants of single-layer and multi-layer curved panels for construction work to be carried out on the permafrost and usual ground found in Tyumenskaya Oblast, in northern Krasnoyarskiy Kray and in the Komi ASSR.

Series 122 -- for construction on the Baykal-Amur Trunkline, in Magadanskaya Oblast, Yakutskaya ASSR and in other regions having complicated conditions, permafrost and seismic disturbances on the order of 7, 8 and 9 balls. Series 164-07 was developed for the natural climatic conditions found in the central Ob' River region. Series 164-07 VMU -- for the specific conditions which prevail in the Yakutskaya ASSR.

The apartments of these series have an overall area which exceeds by 10 percent the norm set forth in SNiP /construction norms and regulations/ I-II and 1-71 for the central zone of the USSR, a story height from floor to floor of 3 meters, kitchen-dining areas of no less than 8 square meters, special cabinets for the drying of clothes, linen and footwear, triple glazing of windows, ventilation with mechanical stimulation and warming of air and in some instances moistening of the air. The apartment houses consist of a large building, garbage lines, elevators in buildings higher than four stories, a triangular shaped vestibule, benches in the elevator cars and a technical floor on which the engineering lines and technical and auxiliary facilities. In those areas where it is possible, a warm passageway is installed between the elevator cars and the service buildings.

In the architectural solutions for the facades of large-panel dwellings, special attention is given to the plastics and color and also to the careful tracing of the details of the ventilated cellar, the technical story, porches, entrances, and balconies. Special attention is given to these latter elements of a building. What is most preferred in the North -- loges or balconies? It is our opinion that loges, particularly glassed-in ones, are most preferred. During the summer they serve as verandas with expandable or jalousie windows and in the winter they serve in the role of a cold ventilated facility for the storage of products, which is a necessity for the northern region, especially remote regions. All of the series

for large-panel apartment houses are based upon use of the unit-section method or the unit-element method and this ensures diversity in the building solutions, with observance of the demographic requirements.

The design solutions for these buildings are for the most part similar to the all-union series. Of interest is the Series 122 solution, which was developed by LenZNIIEP jointly with TsNIISK /Central Order of Red Banner of Labor Scientific-Research Institute of Structural Parts imeni V.A. Kucherenko/. It calls for a new structural system which will ensure the integrity of a building under complicated seismic and permafrost conditions. This applies first of all to the means for active seismic protection in the form of disconnecting contacts which enable a building to become adapted to different regimes of seismic fluctuations in their broad spectrum.

At the present time, using progressive type plans which take into account the conditions found in the Far North, large-panel apartment houses are being erected in Surgut, Nadym, Novoye Urengoye, Nizhnevartovsk (see Figure 1) and Nefteyugansk -- Tyumenskaya Oblast; in Noril'sk -- Krasnoyarskiy Kray; Yakutsk, Tynda, Shimanovsk, Neryungri, Zipkuna, Zolotinka and other populated points along the Baykal-Amur Trunkline; Severodvinsk -- Arkhangel'skaya Oblast.

In all, 20 large-panel housing construction plants with a capability of approximately 2 million square meters of overall space annually are being built or modernized in regions of the north using progressive standard plans of LenZNIIEP.

For the production of items for the northern series of standard house plans, LenZNIIEP is producing plans for the technology and non-standard equipment of large-panel housing construction enterprises. In the development of these plans, special attention is being given to raising the technical level and quality of the output, introducing a "flexible technology for plant production, to the further mechanization and automation of processes, to lowering the laborious nature of the work, to raising the degree of plant readiness of the items being produced and to introducing automatic posts for controlling their quality.

The chief requirement for the conditions found in the Far North, with regard to the production and installation of large-panel and frame-panel buildings is that of reducing labor expenditures to the maximum possible degree. This requirment is conditioned by the economics involved. It is generally known that the task of bringing in and settling a worker, technician or engineer in the Far North costs the state 15,000-20,000 rubles. The labor expenditures for the erection of large-panel buildings at a construction site are two times lower than those for brick buildings. But the number of workers at house construction enterprises in the Far North is the same as, and in some instances even greater than that at DSK's /house-building combine/ located in the middle zone of the USSR. Thus LenZNIIEP considers its principal problem with regard to improving the technology for completely prefabricated housing construction to be that of achieving a sharp reduction in the number of workers engaged in production operations.

For the purpose of solving the tasks concerned with improving plant housing construction, the plans have consistently included and are including progressive technological solutions, the results of experimental design work and the development of new equipment and inventions of new machines and technological equipment.

Thus the plans for expanding and modernizing the Magadan, Surgut, Nadym and other KPD's /large-panel plant for housing construction/ call for highly mechanized conveyer lines for the production of industrial items on multi-purpose pallets having adjustable side surface equipment. These lines should be equipped with new lifting-transfer equipment and tunnel quick response continuous action chambers.

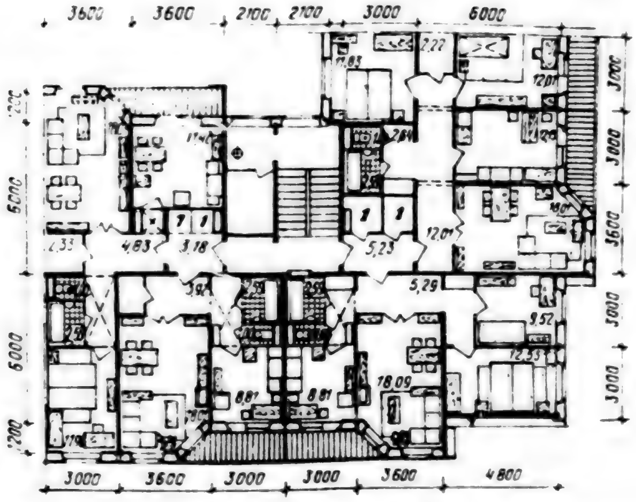

Figure 1. Plan for a corner block section for a Series 112 dwelling

The use of tunnel quick response heat treatment chambers of continuous action instead of ground-type tunnel chambers of periodic action, as called for in the standard plan of a KPDS plant, makes it possible to reduce the number of chambers and lower the cost of construction and the expenditure of steam. The introduction of this particular solution into operations at the KPD plant in Shimanovsk (for the Baykal-Amur Trunkline) reduced the cost of construction by 90,500 rubles, labor expenditures by 127,000 man-days and steam consumption by 8,922 tons annually.

The situation with regard to the erection of large industrially produced public buildings is considerably worse than that for housing construction in the North.

The trend adopted in the early 1970's with regard to the planning and construction of large public buildings, based upon industrial items of frame-panel construction and in accordance with the all-union II-04 and IIS-04 catalogs, has still not been realized either at existing KPD enterprises or those erected in regions of the North and the importing of these items from other regions of the country is limited owing to the fact that they are in short supply. Thus the northern cities of Siberia are experiencing a critical shortage of children's institutes.

In this regard, the conversion of KPD plants over to the production of large public buildings using the large-panel method constitutes a more promising solution and requires urgent measures.

Just as in the past, large-block construction, which is also considered to be an industrial complete prefabrication method for erecting buildings, warrants attention. Under conditions involving a dispersed and negligible volume of construction, large-block buildings possess definite advantages over large-panel types: the large blocks are suitable for transporting, they are less susceptible to deformation and they do not require heavy crane equipment; the specific expenses required for

erecting a plant for the production of large blocks are considerably less than that required for the construction of a KPD plant. The institute has developed standard plans for 2-5-9 story block sections and Series 123 apartment houses and also plans for large-block school buildings and, kindergartens and day nurseries.

Series 123 large-block buildings are under construction in a number of cities and settlements in the Yakutskaya ASSR, Magadanskaya Oblast, along the Baykal-Amur Trunkline and at Oka-na-Sakhaline.

The chief requirement of northern cities -- an all-round system of construction of buildings and installations using the industrial method. Under conditions involving considerable distances from construction bases and irregular deliveries of construction structures from other regions, the erection of plants having a limited capability -- 15,000-20,000 square meters of overall space annually, with the all-round production of items for housing and large public buildings -- appears to be quite promising. This requires the development in the near future of a standard plan for such a plant.

In the interest of developing and improving large-panel housing construction in Siberia, the Far East and the Far North, use should ideally be made of the institute's proposal for erecting buildings having only a few floors, a steel framework and triple-layer panels with efficient heaters. The construction of several dozens of such buildings along the Arctic coastline and technical-economic estimates serve to confirm the fact that, compared to dwellings made out of traditional materials (concrete, brick, wood), buildings constructed with the use of aluminum have a weight that is 15-20 times less, labor expenditures are reduced by 5-7 times and the overall cost by 15-25 percent.

The institute has developed a series for dwellings and public buildings of only a few levels, for the industrial production of which the USSR Ministry of Geology is building a plant in Sayanogorsk in Krasnoyarskiy Kray which will have a capability for producing 400,000 square meters of overall space annually.

According to heat engineering computations, in many regions of the Far North the thickness of external protective panels is 40-50 centimeters or more. Thus the heavy aggregate concrete panels of external walls of large-panel apartment houses should be replaced by light aluminum panels of the "Sandwich" type. Several such 48 apartment buildings have been built in the settlements of Dikson and Cherskiy using the institute's plans and we believe that they have proven the feasability of this "covering" for a large-panel building both during the stage of construction and during operation.

The production of structures out of light concrete on a porous filler and concrete on crushed stone is carried out as a rule using an imported filler, since the regions of the Far North lack the supplies of gravel, crushed stone and clay required for producing porous clay filler having the necessary properties.

At the same time, it is known that the regions of the North have unlimited supplies of sand at their disposal. Thus the institute endorses and widely recommends the organization of the production of large-panel structures made out of autoclave concrete of a cellular, porous and dense structure. This will have a great effect with regard to reducing the weight of buildings and achieving economies in the use of cement.

Natural-climatic and engineering-economic factors exert a great effect on the specific nature of industrial housing construction in the Far North. The principal factors include: the dispersed nature of construction in newly developed and difficult to reach regions; the duration of the construction season during the severe winter period with temperatures down to -55 to -60° Centigrade; permafrost ground; high seismic disturbances in some regions.

Thus, when developing the plans for large-panel buildings, the institute eliminates the use of wet processes during the erection of buildings. However the introduction of this important statute is being delayed by the absence of suitable polymer materials and hermetic sealants.

The low temperatures of a prolonged winter in the Far North impose definite requirements with regard to organizing the production of reinforced concrete products. Enclosed and heated storehouses are required for those inert materials which freeze together when stored outdoors and form a difficult to break down monolith. The technology at active enterprises calls for the products to be held for 4 hours in the department. Such products should not be stored outdoors or at a temperature of 30-50° Centigrade. Thus a requirement also exists for enclosed heated storehouses for finished reinforced concrete items, such that they can be stored for 10-12 hours in order to acquire a definite toughness and resistance to low temperatures.

In the northern regions, where the volumes of large-panel civil housing construction are increasing and will continue to increase, tremendous importance is attached to realizing economies in the use of metal, cement, labor and power for the heating and ventilation of buildings during operations.

During the past five-year plan, as a result of having improved the architectural-planning and structural solutions in the plans of LenZNIIEP, economic savings were realized as follows: 15,000 tons of metal, 40,000 tons of cement, 400,000 man-days of labor expenditures and also more than 50,000 gigacalories of thermal power annually and this made it possible to reduce the importing of conventional fuel into the remote regions by 7,000-8,000 tons.

The principal methods have been developed at the institute for realizing long-range improvements in standard planning for large-panel apartment houses in regions of the North.

In conformity with the all-union program, new types of dwellings are being created for construction in future years, with an increase in the overall area and an improvement in the comfort level of the apartments.

The search is continuing for a typical northern architecture for apartment houses, with tracing of the parts of entrances, porches, ventilated basement, proper use of technical floors and so forth.

In the sphere of structural improvements, LenZNIIEP is working on an improvement in external protective panels. Single-layer lightweight aggregate cement panels for external walls, which are presently being produced at a majority of plants in the North constitute an unacceptable waste. They are extremely heavy, they consume great quantities of materials and they are not very efficient with regard to retaining heat in buildings.

In the opinion of the institute, large-panel construction must in the near future convert over to external panels, inter-apartment and inter-room partitions and sanitary facilities made mainly out of lightweight efficient materials and thus we are carrying out scientific-experimental and planning work along a broad front on multi-layer panels involving the use of aluminum, polymer materials, asbestos cement and fibred cement with an effective heater.

The plans call for a further improvement in the level of engineering and sanitary hygienic equipping of apartments and dwellings.

The long range municipal construction trend associated with active social changes in the living conditions of people in regions of the North is generally well known. The new standard plans will call for the first and technical floors of buildings to have receiving points for laundry and dry cleaning, facilities for receiving requests for domestic and trade services, facilities for automatic machines, rooms for club and social work with children and adults, self-service shops and so forth.

For solving these and other tasks, the institute developed and presented for review by RSFSR Gosstroy and Gosgrazhdanstroy a plan for an "all-round program for scientific-research and planning work for civil housing construction in the northern regions of the country for the period up to 1990," in which considerable attention will be given to long-range and research work in the sphere of realizing improvements in large-panel construction.

However, the principal requirement for a sharp improvement in the architectural-planning, structural, construction-installation and operational qualities is the need for the mandatory carrying out of experimental construction prior to the development of the standard plans. Unfortunately, proper importance is not being attached here to experimental construction throughout the country as a whole. The institute, over a period of several years, is erecting experimental dwellings of a new type in Vorkuta and Yakutsk, where the plans call for a check to be carried out on their planned structure. Only such a check will serve to guarantee the creation of housing and public buildings of mass construction at a level in keeping with the modern social, economic and engineering requirements.

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INCOMPLETE CONSTRUCTION PROJECTS DISCUSSED

Moscow VESTNIK STATISTIKI in Russian No 4, Apr 82 (signed to press 25 Mar 82) pp 19-28

[Article by M. D'yachkov: "Questions of Recording and Regulating Unfinished Capital Jobs (for discussion)"]

[Text] The "Basic Directions of USSR Economic and Social Development in 1981-1985 and Up To 1990" anticipate a broad program of fundamental improvement in construction and increased capital investment effectiveness. In this regard, primary attention is being focused on ensuring the prompt start-up of fixed assets and production capacities, the concentration of capital investments and material resources on the most important projects, the even and complete start-up of production capacities and projects in the nonproduction sphere, and the concentration of capital investments foremost on enterprise renovation and retooling and on completing projects previously begun. The allocation of funds for expanding existing enterprises and installing new ones is permissible only if it is impossible to ensure the release of output by improving the use of available production capacities or by renovating or retooling them. All this must help intensify construction production by shortening the production cycle, which also means reducing the amount of unfinished construction.

Work at any construction site is a process consisting of uninterrupted growth in the readiness of the project or enterprise being installed as a whole. Unfinished construction reflects the absolute amount of this work, while the "readiness" indicator reflects the ratio of unfinished construction to the total cost of the building, structure or other type of fixed assets being erected.

Unfinished construction is determined in the plan of each individual construction site by direct budget calculation based on data on the planned work volume and start-up of fixed assets. Inasmuch as the functioning period of a construction site is limited to a single production cycle, it would be unjustified to calculate unfinished construction norms for it. The calculation is made on the basis of construction duration norms which are periodically issued as standard norms differentiated by branch and type of construction. It is these exact norms which are the criteria of the qualitative aspect of the work.

Construction duration indicators perform a double function. They serve the operative tasks of planning, monitoring and evaluating the activity of each

construction site and are also used to calculate the average actual duration of construction, its dynamics and level as compared with norms on the scale of entire branches of economic activity.

The tasks of regulating unfinished construction (incomplete capital jobs) arise when shaping indicators at the level of an aggregate of construction sites encompassing capital investments on the scale of national economic branches, entire economic systems, and individual ministries and departments. Of course, regulation tasks are considerably more complex here than in industry, especially in a branch like machinebuilding, a large-series, mass-production branch in which production technology and organization are set quite precisely and work rhythm is stable. The output structure is also relatively stable, and the work itself takes place under stationary conditions. The absence of such conditions in construction complicates regulating unfinished output there. But the method of regulation used in industry can be used in construction on a macrolevel and has been justified by regulation practice itself.

In regulation, we naturally cannot fail to take into account those features inherent to the individual branches of construction. These deal first of all with such important indicators of activity as production cycle length, dynamics of expenditures growth, and the size and cost of the enterprises and projects being installed.

Indicators of change in capital investment volume in comparison with changes in unfinished construction are given in Table 1.

Table 1. Relationship of Capital Investment and Unfinished Construction Volume in State and Cooperative Enterprises and Organizations (excluding kolkhozes), 1980 in percent of 1965*

branch of industry	capital investment volume (in comparable prices)	amount of unfinished construction (in actual costs to builders)
electric power engineering	200	271
coal industry	171	186
petroleum and gas industry	372	371
ferrous metallurgy	197	272
chemical and petrochemical industry	208	333
machinebuilding and metalworking	414	416
timber, wood-processing and pulp-paper industry	173	175
building materials industry	217	186
light industry	262	186

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*See: the statistical annual "Narodnoye khozyaystvo SSSR v 1965 g." [USSR National Economy in 1965], pp 534, 542, and "Narodnoye khozyaystvo v 1980 g." [National Economy in 1980], pp 338, 345.

For the national economy as a whole, unfinished construction as a percentage of capital investment volume for the year has risen as follows over the past 15

years: from 69 percent in 1965 to 87 percent in 1980. This trend is also characteristic of a majority of branches of industry. However, the level of unfinished construction is considerably lower in light industry than in heavy industry. It might be assumed that one substantial reason for this is the relatively small number of light industry enterprises themselves. Different, shorter periods are required to put them up. Production cycle length is therefore shorter here than in heavy industry.

However, there are also branch-wide factors influencing the level of unfinished construction. In particular, concentrating capital investment and material resources at the most important construction sites and limiting the number of projects being built simultaneously help to reduce it. In the years ahead, the amount of unfinished construction must be brought down to the normatives, as is outlined in the "Basic Directions."

A census was taken of unfinished construction in 1981. The census materials are intended for use in studying its structure so as to reveal reserves for lowering the level of unfinished work, preventing any scattering of capital investments, and increasing construction concentration.

Unfinished construction (as an indicator describing the overall amount of unfinished capital investment) cannot be studied separately from indicators of unfinished construction production which describe the activity of the contractor construction organization system. Herein lie the peculiarities of the construction economy, the complexities of its organization, planning and financing.

The construction site is the unit of observation in capital investment statistics, including unfinished construction (incomplete capital investment). Overall construction site leadership belongs to the builder. A capital investment limit and a plan for putting fixed assets and capacities into operation are approved for him. Each construction site consists of an independent budget (capital investment balance) and has a bank account for calculations with suppliers, the contractor and other agents.

When work is done by contractors, which covers 88 percent of all the construction and installation work in our country, the builder emerges as client in his cost-accounting relationships with the contractor organization.

In accounting and in the national economic plan, capital investment volume and the start-up of fixed assets and capacities are reflected by ministry and deparment, as well as by individual branch of the national economy, delineating the largest construction sites. The program of construction industry enterprise activity is determined correspondingly. Construction administrations, trusts and associations bear responsibility for following the established construction duration norms.

As distinct from the construction site, the contractor construction organization is a continuously-operating enterprise. Like the industrial enterprise, it has normed circulating capital, of which unfinished construction production is an integral part.

Consequently, there are two information flows in construction statistics. One reflects the overall amount of capital investment and fixed assets being put into operation and is shaped by reporting data from the builder. Related to it are the indicators of time involved in putting up projects or enterprises as a whole and amount of unfinished construction. Such data are used when evaluating national economic plan fulfillment and fulfillment of individual branches of it, as well as fulfillment of the plans of individual departments and individual construction sites.

Another flow is reporting from the cost-accounting contractor construction organization system. It reflects fulfillment of construction-installation work programs in terms of contract agreements and amount of finished, commodity construction output. The maximum amount of contractor work is determined first of all by the scale of capital investment and its structure, by construction-installation work's proportion of the overall amount of capital construction. Like the builder, the construction organization relies in its activity on the exact same technical and estimate-planning documentation. This documentation determines the overall amount of capital investment and the cost and capacity of the fixed assets being created.

All these can be considered underlying data for planning and recording fulfillment of the activity plan of these two systems. However, there are substantial differences: the builder's plan, as does recording its fulfillment, reflects the size of all capital investments shaping the cost of the fixed assets being put into operation. And in the construction organization plan and reporting we find indicators of construction-installation work volume and cost, from which commodity, final construction output takes shape in the start-up stage.

The functions of the contractor organization are limited to producing construction output. But this output is only a portion of the capital investment, hence the difference in the indicators of unfinished construction and unfinished construction production. The first reflects the total amount of expenditures on incomplete capital investments, which is related to the builder's reporting and plan indicators. The second describes the amount of construction-installation work done, the construction production stockpile, which is related to the contractor's reporting and plan indicators.

Thus, in capital construction statistics, unfinished work indicators are simultaneously contained both in the report of the contractor construction organizations (as unfinished construction production) and in the reporting of the builder himself (as incomplete capital construction or unfinished capital investments). In this regard, the indicators of the contractor construction organization are taken from current accounting data. But the indicators of the builder which apply to work done by a contractor are data from current-operations records based on contractor information.

In providing an overall picture of the level of incomplete capital investment, the builder is forced to rely both on his own information from his current account and on data obtained in finished form from contractor records. With such organization of unfinished construction records, great accuracy is required to avoid possible discrepancies in indicators being simultaneously reflected in the

reporting of both the builder and the contractor. This is all the more essential if one is aware of the scope of our capital work. At the same time, it seems to us necessary that the interconnections between data on unfinished construction in terms of summary indicators be periodically checked in a cross-section of individual construction branches and for the national economy as a whole. The underlying indicators for this are contained in the existing system of recording.

When a particular construction project is put into operation, its volume, as expressed in estimated cost, is determined according to the plan. But its actual net cost is calculated using analytical accounting data, which is organized by project. In the course of the work, certain difficulties arise when determining the amount of unfinished construction as expressed in estimated cost, as the stage or structural element, that is, a consolidated portion of the project, is the unit of normative calculation under estimate compilation methodology, while the project as a whole is the unit of reporting calculation.

The new procedure for planning and calculation in capital construction which is outlined in the CPSU Central Committee and USSR Council of Ministers decree of 12 July 1979 must help improve the quality of record-keeping for it. In accepting work in the form of commodity output as expressed in finished projects, lines and start-up complexes, the builder thus obtains a solid base for evaluating their actual amount and normative (estimated) cost. The readiness of output being marketed is determined directly on the basis of the established technical documentation in this instance.

As a consequence of this consolidation of calculations, unfinished production is increasing in construction contractor organizations. And this in turn leads to complications in current accounting and in calculating output net cost and profitability.

Under current procedures, the monthly information being supplied the builder by the contractor is drawn up on the basis of a "completed-work journal." Work is recorded in the journal in physical terms by individual project element and type of work. Changing them over to estimated prices often is done very arbitrarily, by calculating percentage of readiness. At one time, this accounting practice did not cause great difficulties inasmuch as there was very little unfinished construction, less than one percent of the annual contractor work volume in 1965. The situation has now fundamentally changed, with the indicator of unfinished work reaching the many billions of rubles. Moreover, the area of application of this indicator has been expanded. Under these conditions, the basic task reduces to finding a standard, single method of recording unfinished construction production. We need to have data, by project, on the estimated cost structure of projects being put up in a cross-section of their individual components as an initial document for evaluating unfinished construction production. Some arbitrariness is also possible here, but a unified methods base is ensured, enabling us to verify its proper use and to reveal deficiencies in it.

One substantial defect in the recording of unfinished construction output is the discrepancies in work profitability indicators when comparing its level in terms of marketed construction output with the level in terms of unfinished construction production (unrealized profit).

The basic tendency has been for the first of these indicators to be considerably higher than the second. The following indicators can be considered typical in this regard (see Table 2).

Table 2. Level of Profitability in Construction (in percent of estimated work cost)

	1975		1978	
total for the system of contractor organizations	profit from work released	unrealized profit	profit from work released	unrealized profit
department as a whole	14.6	12.0	12.6	8.3
including:				
main administration No 1	12.3	9.6	15.8	8.2
main administration No 2	11.9	11.8	8.8	8.9
main administration No 3	21.3	22.1	19.5	15.3
main administration No 4	14.7	11.4	10.1	8.6

The presence of large discrepancies between the levels of profitability of finished and unfinished work having the exact same orientation obviously cannot be ignored when evaluating the reliability of such reporting data. Eliminating this kind of shortcoming presupposes periodic checks on the status of unfinished construction. For day-to-day observation, it would be appropriate when determining the amount of unfinished construction production to adopt an identical level of profitability for both finished, marketed construction output and unfinished construction production.

The amount of unfinished work being done by the contractor method would thus be reflected simultaneously in the final indicators of enterprises of the two systems and would serve different purposes. For the builders, this indicator describes funds temporarily immobilized in construction and for the contractors it is the largest portion of circulating capital designated for operating them as cost-accounting enterprises.

Table 3 gives an idea of the relationship of the indicators of unfinished capital investment of the builder and unfinished construction production of contractor organizations.

Table 3. Unfinished Construction At State and Cooperative Enterprises and Organizations (excluding kolkhozes), USSR as a whole, end of the year, in billion rubles*

	1965	1980
builders		
unfinished construction	29.6	105.1
contractor construction-installation organizations		
unfinished construction production	0.38	40.7

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*Table calculated using data from the statistical annual "Narodnoye khozyaystvo SSSR v 1980 g." [USSR National Economy in 1980], pp 345, 510, 516.

In and of itself, unfinished construction-installation work comprises the bulk of the unfinished capital investment volume. The amount of unfinished construction exceeds the amount of unfinished construction production more than 2.5-fold. Unfinished construction includes all types of unfinished capital investment, including construction-installation work and including that portion of it being done by the direct-labor method. It is also significant that a certain amount of calculation based on partial readiness was retained in construction until recently.

Unfinished construction production now turns out to be the largest portion of construction industry circulating capital.

In 1965, unfinished production in construction industry totalled 0.4 billion rubles, as against nine billion rubles in industry. The situation had changed radically by the end of the period under review (as of 1 January 1981): in construction industry -- 41 billion rubles, and in industry -- 26 billion rubles. These indicators comprise, respectively, 70 percent of annual output volume and four percent.

The indicators of project construction duration and amount of unfinished work are currently unfavorable. The overall estimated cost of all projects under construction exceeds 4-5 yearly capital investment plans, and average construction duration is 5.7 years, given a normative duration of 3.5 years. And the amount of unfinished construction is growing. This situation naturally intensifies the attention being paid to the methods questions we are examining.

The setting of construction duration rates, like the setting of rates for unfinished work, is based on the principles of shaping average norms and normatives for the same kinds of work and branches of production. Normative data are periodically reviewed in view of progress in production equipment and technology.

The method of setting in construction is different than that used in industry. The unfinishe industrial production norm is set based on the length of the production cycle and the expenditures growth coefficient. And the formula for calculating the normative of circulating capital for unfinished production (N) is provided correspondingly:

$$N = \frac{C}{T} \times T^{c} \times K^{gr} ,$$

where C are expenditures on gross output production;
T is the length of the period (quarter, half-year, and so on);
T^{c} is the length of the production cycle;
K^{gr} is the expenditures growth coefficient.

The most complicated calculation is that of the expenditures growth coefficient (percentage of readiness). At enterprises where expenditures are uniform, this indicator is determined using the formula:

$$K^{gr} = \frac{C^{o} + 0.5\ C^{s}}{C^{o} + C^{s}} ,$$

where C^o are expenditures made one time, at the start of production;
C^s are subsequent expenditures prior to the end of output production.

If expenditures growth is nonuniform, of course, the calculations are more complex. In industry as a whole, we are dealing with a method of individual rate-setting, while in construction, we are always working from standard norms. This applies both to indicators of construction duration and to indicators of stockpiles. In construction, the duration of the production cycle is determined by the time involved in producing finished, commodity construction output. And these periods (bearing in mind what they are in industrial construction, much less transport) are not weeks or months or even quarters. As distinct from an industrial enterprise, the construction site itself is not a stationary production unit. The periods of its activity are set using standard norms of duration for putting up fixed assets projects. Estimates are drawn up using consolidated norms with allowances, which is confirmed by the presence in them of a reserve for unforeseen work and expenses equivalent to 10 percent of the overall cost of the projects and enterprises being planned. The standard construction duration and stockpiles norms currently in effect were issued in 1981. In industrial construction, these indicators are specified for 35 branches and subbranches, in agricultural construction -- for six subbranches, in transport construction -- for seven, in nonproduction construction -- for six, and so forth.

The national economic significance of these normatives is that they serve as the criterion for substantiating the actual level of unfinished construction and prevent the directing of surplus funds into capital construction. The search for ways of best resolving this task is one of the important conditions for improving the construction economy. And the methodology of recording and statistics, increasing the reliability of reporting data, are of considerable significance in this effort.

The complexity of the problem touched on here is confirmed, in particular, by the fact that one can encounter in the press diametrically opposite estimates of the level of unfinished construction. One article will maintain that the norms of unfinished construction are not being greatly exceeded at the present time,[1] while another proves the reverse.[2]

The reason for such disagreements is the differing methods of calculation. Concerning the analysis of unfinished construction, the author of the first of these articles writes: "At present, such analysis is essentially quantitative in nature.... If the actual indicators are greater than the norm, this is appraised as being a negative phenomenon."[3] Breaking down indicators of normative assignment fulfillment into quantitative and qualitative, he procedes from the fact that the indicator of construction site readiness is the criterion of qualitative norm fulfillment. However, this is justified only when the individual construction site is the object of study. Here, there is an obvious linear dependence between unfinished construction growth and readiness, as the final indicator -- overall estimated cost of the construction site -- is generally a constant value. And the work structure is defined quite precisely, being fixed

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1. I. Perepechin, VESTNIK STATISTIKI, No 10, 1980, p 15.
2. P. Podshivalenko, VOPROSY EKONOMIKI, No 1, 1981, p 24.
3. I. Perepechin, VESTNIK STATISTIKI, No 10, 1980, p 10.

in the construction project plan itself. But as an object of statistical study, an aggregate of construction projects has its own features which cannot be ignored. In particular, there can be structural shifts causing deviations of readiness indicators from indicators of unfinished construction. And the lag of the former behind the latter cannot, in and of itself, serve as a criterion when evaluating the qualitative level of unfinished construction norm fulfillment. Let us also note that it is not just the production structure, but also the production volume which often turns out to be a variable in the aggregate of construction projects.

Moreover, in the article we are referring to here, the interrelationships among unfinished construction, construction duration and construction readiness are being examined in abstract formulas as applicable to an abstract construction site.

Now let us examine another question. What is the difficulty in statistically studying unfinished construction at an aggregate of construction sites as compared with an individual construction site? Any aggregate of construction projects consists of observation objects, each of which is invested with its own individual features. Construction is by no means mass production, series production or even small-series production. Even when projects are put up following standard plans, it is necessary to "tie" them to local conditions. The geography of the construction site sometimes causes substantial fluctuations in the work structure and in final normative (estimated) cost. The first problem to arise, therefore, is to shape average indicators of construction duration, level of construction readiness and level of unfinished construction. And the methods of calculating these indicators are of important significance. For example, the average construction duration calculation can be based either on a simple or weighted arithmetic-mean formula or on a harmonic-mean formula, which has been used for many years in statistics. Depending on the mean used, its statistical indicators change and, in so doing, change the final evaluation of construction activity.

The same considerations must be heeded when statistically studying construction readiness or, in other words, the relative level of unfinished construction. Alternative resolutions are possible when determining the calculation base for this indicator. And the indicator itself changes depending on this. But when analyzing a construction site being studied individually, the base is stable, as it is always the estimated cost of the construction site.

These remarks concerning the studying of unfinished construction apply directly to the question of the methods of evaluating fulfillment of normative unfinished construction indicators at the level of whole branches of the national economy and industry, of individual departmental systems and economic regions. But when the reference goes beyond methods of analyzing fulfillment of unfinished construction normatives, then it is very difficult to agree with recommendations favoring a two-stage method of analysis, that is, dividing it into quantitative and qualitative analysis. Each norm is intended for properly regulating the level of expenditures or resources of an enterprises and, in so doing, to serve as a measure of the quality of its work. In this sense, the system of standard construction norms serves as the starting point for all planning and design calculations. Inasmuch as all these norms are means, some allowances in them are

unavoidable. Given this situation, it is hardly appropriate to orient ourselves towards evaluating the level of unfinished construction with consideration of qualitative norm fulfillment.

The task of studying and monitoring norm fulfillment consists in precisely measuring deviations of the actual level of unfinished construction from the normative. In and of itself, such methods work is very complex. It deals not only with the problems of unfinished construction statistics, but also with current, primary record-keeping.

But the causes of deviations of the actual level from the normative are determined using factor analysis, which elucidates the most essential factors in such deviations, in particular: changes in work structure, average duration of the production cycle, construction site geography, and others. This task of construction statistics is one of the most pressing ones, since the actual amount of unfinished construction greatly exceeds the normative level.

The process of statistically studying the use of unfinished construction norms, just as for fixed assets depreciation norms, overheads norms, material and labor expenditures norms, return on capital, and so on, assumes an evaluation of assignment fulfillment and then an elucidation of the nature and causes of possible changes, as well as an evaluation of their scope.

Substituting for such analysis a single, totally abstract formula called upon, supposedly, to determine the qualitative aspect of norm fulfillment does not resolve the task of statistically studying unfinished construction. And in fact, to judge from its title, the above-mentioned article by I. Perepechin is devoted to an analysis not of individual construction sites, but to statistical aggregates of them.

All the above permits the following conclusions:

1. The scope of capital investment and the tasks of perfecting planning make new and greater demands on the methodology of recording and statistically analyzing unfinished construction.

2. The new recording problems result from radical changes in the very system of capital investment planning and financial calculations in construction.

3. The reliability of reporting indicators is a prerequisite to properly evaluating the actual level of unfinished construction as compared with the normative. Under present conditions, this aspect of the analysis is especially important, inasmuch as a large gap is observed between the actual level of unfinished construction and the normative.

4. The norms of unfinished construction serve as a measure of construction quality. But a statistical study of the dynamics or structure of unfinished construction cannot be substituted for monitoring the observance of normatives as the limiting value of the unfinished construction indicator. Such statistical study requires the use of factor analysis methods, and one assumes that it will reveal and measure the influence of individual factors on the final indicator, in this instance, deviations of the actual level from the normative.

It is appropriate to make the statistical analysis on a base of standard methods which would permit a more substantiated determination of the range of factors being studied, calculating the influence of each of them, the methods of revealing and measuring them, and the sources of needed information.

Studying the qualitative aspect of standard rate-setting for unfinished construction is a special task which must be resolved in the course of drawing up such norms and subsequently improving them.

Use of the rich experience of statistical methodology is a necessary prerequisite in resolving the complex task of organizing the statistical analysis of unfinished construction.

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CONSTRUCTION MACHINERY

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REPAIRABILITY OF EQUIPMENT IN NORTHERN AREA, SIBERIA

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[Article by V. V. Kolesnichenko, laboratory chief at the TsNIIOMTP (Central Scientific Research Institute for the Organization and Mechanization of and Technical Aid to Construction) of the USSR Gosstroy: "Repairability of Equipment for Siberia and the North"]

[Text] In the North and Siberia, which are experiencing a shortage of human resources and which do not have a modern operation-repair base available to them, it is very important, along with adapting machinery designs for operation at low temperatures, to be able to maintain the machinery in operating condition with minimum expenditures of labor and materials.

Lowering labor expenditures on technical service and repair assumes particular urgency in the case of machinery with higher unit power, as idle time for them in technical servicing and repair is very expensive to enterprises.

One important direction in which lower labor and material expenditures on maintaining machinery in operating condition and on operating it are being ensured, along with raising the level of durability and trouble-free operation, is raising the level of repairability and operational technological efficiency.

Repairability is understood to mean that feature of machinery design which determines their techincal servicing and repair requirements in order to maintain and restore their condition and operability. It is characterized by the presence of technical service and repair operations and the regularity with which they are performed. The fewer the operations and the less frequent they are, the lower the expenditures of labor and materials on maintaining the machinery in working condition and the higher the level of their repairability.

An analysis of the designs of machinery being supplied the North discloses a large number of technical service operations and the high frequency with which they are performed. The frequency of technical service on the T-330 tractor is the same as for tractors produced previously (60, 240 and 960 motor-hours), causing high technical service labor expenditures. Moreover, the established technical service intervals do not correspond to the lubrication schedules set by the ISO 3542-75 standard.

A new GOST [All-Union State Standard] 20793-81 on servicing agricultural tractors has been in effect since 1 January 1982. In accordance with it, TO-1 [technical servicing 1] frequency has been increased from 60-125 motor-hours, TO-2 from 240 to 500, and TO-3 from 960 to 1,000 motor-hours. Many excavators are being based now on industrial modifications of agricultural tractors, and the above-indicated TO frequency will be adopted for them as well, but TO-1 frequency does not coincide with the lubrication schedule established by standard ISO 3542-75.

In a majority of the construction machinery, the period between transmission oil and pressure fluid changes is short. Transmission oil change frequency for the T-130 tractor is the same as for the S-100, although high-quality oil is used in the first, which also now has an oil filter to clean the oil during operation.

The excavator caterpillar track bearing lubrication schedule (50-60 motor-hours) was established more than 25 years ago. Along with high labor expenditures, the frequent oil, lubricant and pressure-fluid changes lead to high expenditures of these products.

The disarray in lubricant expenditures is to be explained by the lack of specialized subdivisions in construction and road machinebuilding. The lubrication procedures established for machinery by their designers are by no means always optimum.

Machinery is shipped many hundreds or thousands of kilometers from their place of use for major overhauls, so they are out of operation for 3-4 or even six months. Machinery idle time during overhaul can be reduced by developing components which would not, as is now the case, require that a complete machine be overhauled prior to being written off. The operability of these machines could be maintained by overhauling their main components during routine maintenance using the unit method. The availability of a stock of exchange components would permit their advance repair, and during routine maintenance, time would be spent only on replacing them, which would also reduce the time involved in routine maintenance.

The ease with which machinery components can be serviced and repaired determines their technological efficiency. Its main elements are ease with which repair operations can be performed, accessibility of components for performing repairs on the machine, ease of monitoring, interchangeability, rebuildability, and components and parts unitization and standardization. Not all construction machinery servicing can be done conveniently. Thus, the pressure-fluid tank level is to be checked with a ruler monthly on the EO-2621A excavator. In addition to labor expenditures, this method of checking also contaminates the pressure fluid. Installing measuring "windows" would eliminate both shortcomings.

Little attention is paid to ensuring parts accessibility when designing machines. For example, the transmission on a bulldozer based on the T-130 tractor must be half-dissassembled in order to remove it. Much disassembly is required to replace a number of components on many machines. This makes it hard to introduce progressive unit-type machinery repair. Parts access is made considerably easier when modular design principles are used, the necessity for which has been pointed out in the "Basic Directions of USSR Economic and Social Development in 1981-1985 and Up To 1990." Such individual modules might be engines, transmissions, distributors, rear axles, hydraulic pumps, hydraulic distributors, generators and other components.

The labor-intensiveness of servicing and repairing machines can be substantially reduced by raising the level of monitorability of their components, which will also make

it easier to diagnose problems in them. It is also important to introduce technical diagnostics methods and means more extensively. Under GOST 20417-75, technical diagnostics systems must be developed simultaneously with the development of vehicle components. They include types of diagnosis, a list of what is done under each type and the frequency with which they are done, parameters of the condition (nominal and minimum acceptable) of the components being diagnosed, and the means and methods of technical diagnostics.

The indicated standard has been in effect si ce 1975, but developers are yet to have developed a technical diagnostics system for a single vehicle. Without technical diagnostics systems, machinery intended for use in the North cannot pass acceptance tests. Machinebuilding must also set up the release of the necessary means for technical diagnosis for machinery.

A significant savings in labor and spare parts expenditures can be achieved by unitization. At the same time, machinery being supplied regions of the North and Siberia is generally not unitized. This applies to the T-130, T-180 and DET-250M tractors which serve as the bases for a majority of the construction machinery and to the mechanical-drive E-652B, E-10011Ye and E-1252B single-scoop excavators. Single-scoop hydraulic drive excavators (EO-4121 and EO-5122) are very poorly unitized.

Single-scoop excavators are currently being changed over to tractor-type caterpillar tread. Here is an opportunity to unitize at least one machinery component. But familiarization with the new caterpillar track design shows that interchangeability is ensured only in the caterpillar track links. The bearing and support rollers and the idle and drive wheels are not unitized either with the tractors from which the links were borrowed or with excavators of identical weight. Given such "unitization," no reduction in machinery repair expenditures is achieved.

All the ministries and departments participating in developing equipment for Siberia and the North must adhere to a unified plan for unitizing them which must be worked out by an interdepartmental commission on the basis of standardizing the machines required.

Machinery unitization is closely linked with modular design principles. Unitization and modular design help improve the effectiveness of machinery repair using the unit method and reduce repair time.

Unitization and the consequent reduction in the number and products list of materials, equipment, tools and attachments needed for TO and repair are of important significance in ensuring machinery servicing and repair effectiveness.

The general rules for machinery technological efficiency are defined by GOST 14.201-73, but GOST 14.202-73 establishes the procedure for choosing technological efficiency indicators. The rules for ensuring the technological efficiency of assembly-unit components are regulated by GOST 14.203-73, and that of parts -- by GOST 14.204-73.

In connection with the connection between operational technological efficiency and repairability, the established operational technological efficiency indicators must be coordinated with the repairability indicators defined in GOST 21623-76. The rules for choosing operational technological efficiency indicators require coordination with analogous repairability rules established by GOST 23146-78. Moreover, when machinery

designs are processed for technological efficiency, consideration must be given to the requirements of GOST 23660-79 on ensuring repairability when developing machinery. It is appropriate when testing machinery for operational and repair technological efficiency to do it simultaneously with testing for repairability under GOST 19489-74. A calculation of the indicators obtained during machinery testing for operational and repair technological efficiency can be made using the methods established by GOST 22952-78.

The technological efficiency of machinery servicing mentioned above is an integral part of the operational technological efficiency of machinery design, to which is related their suitability for installation (disassembly), breaking in, use, transport and storage.

We need to institute indicators for evaluating the suitability of machinery components for each stage of their operation. They might be one-time and specific operational expenditures of labor and time or the cost of the work. Thus, the suitability of machinery components for installation (disassembly) might be evaluated in terms of operational labor intensiveness. The lower the labor intensiveness of the installation, the less time the machine will be inoperable and the more time it can be used to perform work. And thus the higher the efficiency of the machine. Installation (disassembly) labor intensiveness has an especially strong impact on the effectiveness of using those machines which require break-down for transport to the job site and assembly at the new site: tower cranes, large boom cranes on caterpillar and wheeled tracks, and others. For example, individual tower cranes spend up to 10-15 percent of their working time being assembled or disassembled. Designers can lower these expenditures when creating these machines, and they must be encouraged to do so by assembly (disassembly) labor expenditure normatives, which must be included in the normative-technical documentation for developing the machines.

The technological efficiency of breaking in machinery can be evaluated on the basis of the time involved. At present, breaking-in requires 60-100 hours, but inasmuch as the machine is operating at reduced load, under easy conditions, its efficiency is not high. The time involved can be reduced by more thoroughly breaking in individual machinery components when they are manufactured at the plant.

The technological efficiency of machinery components in use is determined by the ease with which their working parts or individual components can be replaced, by the ease with which individual elements can be cleaned, and by the ease of other operations. Thus, the straight-scoop equipment on a single-scoop excavator must sometimes be replaced with a reverse scoop; in boom cranes, the boom itself and its angle need to be changed; in bulldozers, scrapers and graders, the blade must be replaced or turned; in cultivators, the tips of the tines must be changed; in excavator drainpipe-layers, the guide wire must be set in place and moved, and so forth. The less time is spent on these jobs, the more the machinery is used. The normative-technical documents should therefore set the duration or labor intensiveness of each type of technical service, and specific labor intensiveness must be established for individual jobs. Thus, the labor intensiveness of replacing a single cultivator tine might be low, but in view of the fact that it must often be changed due to its low wear resistance, overall labor expenditures will be high. Given this, the specific labor intensiveness of tine replacement over an established period (servicing cycle, repair cycle, operating time, and so on) would obligate developers to improve the technological efficiency of the machinery design in order to lower one-time labor expenditures on tine replacement and to improve their wear resistance.

Individual types of technological servicing are already set for certain machines in a number of state standards. Thus, GOST 22894-77 contains a requirement that operating parts replacement not take longer than 30 minutes for group-3 size excavators or 45 minutes for group-4, with a maximum of two service personnel. GOST 17343-71 indicates that, at outside air temperatures of +40°C to -40°C, an excavator internal combustion engine should be warmed up ["started"] for not more than 30 minutes. The fuel tank capacity on an excavator must permit the engine to run at nominal power for at least 16 hours. If the latter requirement is met, the vehicle will need refueling once a day, which can be done at the beginning or end of a shift on on lunch breaks, with no loss of working time.

The suitability of machinery components for transport can be evaluated in terms of the labor intensiveness of or time involved in switching them from transport to operating status and back and in terms of the speed with which they can be transported by road to their place of use. Thus, GOST 17343-71 contains a requirement that the switching of an excavator moving under its own power from transport to operating status take no more than five minutes.

Machinery components must be easily adaptable to storage when not in use. This is very important for machinery in seasonal use. The adaptability of machinery to storage can be evaluated by the labor intensiveness of preparing it for storage, servicing during storage and removal of the machinery from storage.

The level of repairability and of operational and repair technological efficiency of machinery can be purposefully controlled through state standards. For individual types of machinery (single-scoop excavators, tractors, boom cranes and graders), a number of repairability and technological efficiency indicators are contained in the specifications standards, but their products list is small. The development, coordination and approval of an expanded products list of normed machinery repairability and technological efficiency indicators is therefore a top-priority task in controlling machinery operating features. The institute has worked out proposals on this products list and transmitted them to the USSR Gosstroy.

Improved machinery repairability and operational and repair technological efficiency will enable us to reduce expenditures of time and labor on their operation and repair, which will ensure a rise in the level of machinery use, lower work net cost, reduced manual labor, lower demand for workers, equipment and production space in workshops and repair facilities. In this regard, expenditures of lubricants and pressure fluids in operating machinery in Siberia and the North will be reduced.

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CONSTRUCTION MACHINERY

SUMMARIES OF ARTICLES ON WEATHER EFFECTS ON EQUIPMENT

Moscow MEKHANIZATSIYA STROITEL'STVA in Russian No 4, Apr 82 (signed to press 10 Mar 82) end page

[Abstracts of articles published in No 4 of MEKHANIZATSIYA STROITEL'STVA]

UDC 665.775:666.964.3

Suvorov, L. A., Aniskin, G. A., Oborin, Yu. A., Orlov, V. G. "Device for Preparing Bitumen-Asbestos Emulsion Mastics," MEKHANIZATSIYA STROITEL'STVA, No 4, 1982, pp 8-9. Presents data on mechanizing the preparation of bitumen-asbestos emulsion mastics which enable builders to decide on the appropriateness of introducing BAEM [bitumen-asbestos emulsion mastics] for roofing and waterproofing. Provides a technical description and operating principles of the L-204 mastic-preparation device developed and manufactured in "Sevenergomekhanizatsiya" UMM [not further identified] subdivisions. Illustrations -- 1.

UDC 621.879.482:62-192

Kutuzov, G. S., Khokhlov, B. I. "Durability of Rotary Trenching Excavators," MEKHANIZATSIYA STROITEL'STVA, No 4, 1982, pp 9-10.

Provides research results on the laws of service-life distribution, service life and annual operating time of rotary trenching excavators. Gives numerical values of the parameters of the laws of distribution of these values for the ETR-162 rotary trenching excavator which are obtained by processing operating data. Illustrations -- 2, bibliographic entries -- 2.

UDC 624.138:002.5:625.7/.8

Kostel'ov, M. P. "In Road Construction," MEKHANIZATSIYA STROITEL'STVA, No 4, 1982, pp 16-18.

Analyzes the composition and structure of the fleet of earth-compacting machinery in road construction. Shows that, in the rapid construction of motor-vehicle roads under winter and other special ground and climate conditions, the changing relationship of types of earth, expanding construction geography and increased amounts of earth-moving work demand that construction sites be equipped with large, heavy-duty machinery with outputs of 500-1,000 cubic meters per hour. Test results are given for a 12-ton vibration roller, a 25-ton mesh roller and 12- to 35-ton pneumatic-mesh rollers. Tables -- 1, illustrations -- 3.

UDC 69.002.51-82.004.1
Dvornikov, V. P. "Care of Hydraulic Drives," MEKHANIZATSIYA STROITEL'STVA, No 4, 1982, pp 14-16.
Discusses the negative consequences of water getting into hydraulic drives. Presents optimum conditions for operating construction machinery hydraulic drives. Examines in detail the causes and consequences of dust, dirt and other abrasive substances getting into hydraulic drives and methods of combatting them. Makes practical recommendations on servicing hydraulic drives in construction equipment. Tables -- 1.

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BUILDING MATERIALS

CEMENT ADDITIVES EVALUATED

Moscow NA STROYKAKH ROSSII in Russian No 4, Apr 82 (signed to press 25 Mar 82) pp 46-49

[Article by Candidate of Technical Sciences V. Levina, senior scientific associate in the plant technology laboratory of the TsNIIEPzhilishcha (Central Scientific Research and Planning Institute for Standard and Experimental Housing Planning): "Comparative Evaluation of Domestic Concrete-Mixture Superplasticizers"]

[Text] The concrete-mix plasticizers best known and most widely used in current domestic construction practice are pulp and paper production waste -- sulfite waste liquor (SSB [sul'fitno-spirtovaya barda]) and an SSB processing product -- sulfite-yeast mash (SDB [sul'fitno-drozhzhevaya brazhka]), whose primary components are lignosulfonates. The indicated additives have a strong plasticizing (liquefying) effect on concrete mixtures, but they substantially retard initial setting and hardening of the cement stone, leading to reduced strength if the steaming procedure is not changed.

The superplasticizers (SP), a new type of highly effective plasticizing additives which sharply improve the placeability of concrete mixes while not reducing concrete strength, are free of this shortcoming. This provides an opportunity to obtain maximum plasticizing with rather high doses of the additives (up to 3-5 percent of the weight of the cement), whereas traditional plasticizers cannot be used as concrete additives in quantities exceeding 0.2 percent due to retardation of the hydration hardening process.

Analysis of the chemical structure and composition of the most widely used SP's shows that they are specially synthesized oligomers based on cyclical or heterocyclical water-soluble compounds. In terms of chemical composition, the SP's currently available belong to three groups of compounds: melamine-formaldehyde and naphthalene-formaldehyde resins and modified lignosulfonates.

The different types of SP's have been studied under various conditions and in various cements, in which connection, based just on what has been published, it is currently impossible to properly evaluate or make a substantiated choice of the most promising SP's.

In this connection, the house-building plant technology laboratory of the TsNIIEP zhilishcha has analyzed the work of leading organizations in using domestic SP's in forming reinforced concrete items and it has generalized experience in the commercial introduction of the best-known plasticizer additives.

A number of organizations have been involved in developing SP's: NIIZhB [Scientific Research Institute of Concrete and Reinforced Concrete], VNIIzhelezobeton [All-Union Scientific Research Institute of the Industrial Technology of Prefabricated Reinforced Concrete Components and Items], MKhTI [Moscow Institute of Chemical Technology imeni D. I. Mendeleyev], the Scientific Research Laboratory of the Physicochemical Mechanics of Materials and Technological Processes of the Glavmospromstroymaterialov (NIL FKhMM i TP), MISI [Moscow Construction Engineering Institute imeni V. V. Kuybyshev] and others.

The comparative evaluation of SP's was made using the following criteria: the plasticizing effect of the additive for constant strength indicators, cost, availability, labor-intensiveness of manufacture, environmental impact and servicing personnel.

Table 1 [following page] gives specifications for the most well-known domestic SP's and the technical-economic indicators of their use. It is evident from it that a majority of the additives (10-03, S-3, NIL-10, MMS and KOD-S) possess a high liquefying capacity which raises the mobility of the concrete mixes from 2-4 cm to 20-25 cm of standard-cone settling while retaining strength. One exception is GPD, which demonstrates a low mobility of 7-10 cm O.K. [osadki konusa: standard-cone settling].

The cost of a majority of the domestic SP's is quite high (300-1,100 rubles per ton), increasing the cost of a cubic meter of concrete mix to 2.5 rubles. The following additives are distinguished by comparatively low cost: GPD (45-60 rubles/ton), KOD-S (100-150 rubles/ton), NIL-20 (200 rubles/ton) and S-3 (about 300 rubles/ton).

SP's obtained from melamine-formaldehyde (10-03, NIL-10 and MMS) and naphthalene-formaldehyde (S-3) resins are scarce due to the difficulty in obtaining the initial raw materials, foremost naphthalene, melamine and formalene.

According to the data from corresponding administrations supplying the raw material, NIL-20, GPD and KOD-S will not be scarce within 10-15 years.

The 10-03, S-3, NIL-10, NIL-20 and MMS plasticizer additives are obtained using quite a complex and labor-intensive technology. The GPD and KOD-S are distinguished by the greatest simplicity and least labor-intensiveness of manufacture.

Analysis of the results obtained shows that the use of SP's enables us to obtain a technological impact along one of the following lines:

increase concrete mix mobility from 2-4 cm to 20-25 cm O.K. for a constant water-cement ratio, that is, obtain highly mobile, non-stratifying concrete mixes. This enables us to improve mix transportability, improved placeability, the partial or total elimination of vibration and a concomitant significant improvement in working conditions, simpler casting equipment, lower expenditures on maintenance and operation of equipment and forms, and improved finished-product surface quality;

a 20-30 percent reduction in concrete-mix water content for constant mobility and 30-40 percent greater strength within 28 days, providing an opportunity either to save 10-15 percent on cement while maintaining constant concrete-mix mobility and concrete strength indicators or to reduce the time of heat treatment and, as a consequence, increase the turn-around time for steam chambers and forms.

The high cost of a majority of the SP's and their scarcity assumes that they will not be used to save 10-15 percent on cement, which can be achieved by using ordinary

Table 1. Specifications and Technical-Economic Indicators for Domestic Superplasticizers

(1) Марка СП	(2) Разработчик	(3) Основные составляющие компоненты	(4) Рекомендуемая концентрация добавки, %	(5) Эффективность применения		(8) Гарантийный срок хранения, мес.	(9) Удорожание 1 м³ бетонной смеси за счет добавки, руб/м³	(10) Экономия цемента на 1 м³ бетонной смеси, %
				(6) Увеличение подвижности бетонной смеси (В/Ц-const.), см От 2—4 см. О. К.	(7) Увеличение прочности при сжатии через 28 сут. (О. К.-const.), %			
(11) 10—03	(18) ВНИИ-железобетон	(23) Сульфированная меламинформальдегидная смола	0,4—0,5	до 20	40—60	—	2,4	20—30
(12) С—3	(19) НИИЖБ и НИОПИК Минхимпрома	(24) Сульфированная нафталинформальдегидная смола	0,5—0,8	до 20—22	30—50	6	0,7	20—25
(13) НИЛ—10	(20) НИЛ ФХММ и ТП Главмоспромстройматериалов	(23) Сульфированная меламинформальдегидная смола	0,5—1,0	до 20—25	40—60	6	2,5	15—20
(14) НИЛ—20	•	(25) Модифицированные лигносульфонаты	0,4—0,7	до 15—18	50	—	0,5	—
(15) МMС	(21) МХТИ им. Д. Менделеева	(26) Метакреволмеламинформальдегидная смола	0,5—1,0	до 20—25	40—50	12	2,1	20—25
(16) КОД—С	(22) МИСИ им. В. Куйбышева	(25) Модифицированные лигносульфонаты	0,15—0,25	до 20—22	35—45	12	0,08	10—12
(17) ГПД	•	(25) Модифицированные лигносульфонаты	0,2—0,3	до 7—10	20—35	12	0,05	10—15

[Key on following page.]

Key [to Table 1, preceding page]:

1. SP brand
2. Developer
3. Main components
4. Recommended concentration, in %
5. Effectiveness
6. Increased concrete-mix mobility (water-cement ratio constant), in cm from 2-4 cm O.K.
7. Increased compression strength after 28 days (O.K. constant), in percent
8. Guaranteed storage life, months
9. Increased cost per cubic meter of concrete mix, in rubles/m^3
10. Cement saved per cubic meter of concrete mix, in percent
11. 10-03
12. S-3
13. NIL-10
14. NIL-20
15. MMS
16. KOD-S
17. GPD
18. VNIIzhelezobeton
19. NIIZhB and NIOPIK [not further identified], Ministry of Chemical Industry
20. NIL FKhMM i TP, Glavmospromstroymaterialov
21. MKhTI imeni D. Mendeleyev
22. MISI imeni V. Kuybyshev
23. Sulfurized melamine-formaldehyde resin
24. Sulfurized naphthalene-formaldehyde resin
25. Modified lignosulfonates
26. Metacresolmelamine-formaldehyde resin

chemical additives, but where they can yield the greatest economic impact. This applies to the vibration-hydropress manufacture of stand pipe, the production of tile and panels using magazine technology, the manufacture of densely-reinforced prefabricated and monolithic concrete and reinforced concrete in complex shapes, that is, when the use of cast mixes provides the greatest reduction in labor-intensiveness and accelerates the production process.

In addition to generalizing experience in using SP's in casting reinforced concrete items, the house-building plant technology laboratory ran experimental studies for a comparative evaluation of the technological specifications of the above-indicated SP's under comparable conditions.

It studied the influence of five superplasticizers (S-3, NIL-10, KOD-S combined with NN potassium nitrite, GPD combined with NNKhK calcium chloride nitrate-nitrite, and SDB) on the mobility and strength of heavy concrete of the following composition (per cubic meter of ready concrete mix):

"400"-brand Portland cement	340 kg
quartz sand	310 kg
crushed granite (5-20 mm particles)	940 kg
water	204 kg

The water-cement ratio remained constant for all mixtures, at 0.6. Each of the additives studied was used in three different doses chosen on the basis of recommendations from the developers of the additives. The SDB plasticizer additive was studied for comparison.

Six series of experiments were run, each of which studied one plasticizing additive. Four concrete mixtures were made up for each series (10 liters each): one control mixture (without the additive) and three others with the chosen additive doses.

The concrete-mix mobility was described by the amount of standard-cone settling, in cm (GOST [All-Union State Standard] 10181-76). The compression strength of the sample cubes was determined using GOST 10180-78. Each experiment series used 36 cubes divided into three lots each.

The first lot of 12 cubes was stored so it could harden naturally after the forms were removed and was then tested 28 days later. The second and third lots of 12 cubes each were heat-moisture treated in a steam chamber in the forms as follows: preliminary treatment -- two hours; temperature increased to 80°C -- two hours; isothermic treatment at 80°C -- two hours; cooling until the steam chamber is cool. The second lot of cubes was then compression tested 24 hours later and the third -- 28 days after pouring.

The research results are given in Table 2.

Table 2.

(1) Марка СП	(2) Дозировка СП, %	(3) Подвижность бетонной смеси О. К., см	(4) Предел прочности при сжатии (в МПа через) (5) 28 сут. естественного хранения	(6) 1 сут. после термообработки	(7) 28 сут. после термообработки
(8) НИЛ-10	(13) Без добавки	3	20.3	10.8	20.4
	0.5	9	22.2	10.8	22.8
	1.0	22	21.6	8.6	20.6
	1.5	25	23.0	0.8	14.3
(9) С-3	Без добавки	3	21.3	11.0	24.4
	0.2	7	22.7	11.8	26.0
	0.7	22	21.2	10.0	24.1
	1.2	24	14.2	6.1	16.8
(10) КОД-С +НН	Без добавки	3	19.4	9.8	23.8
	0.2	13.5	18.0	9.8	22.1
	0.25	19.5	19.2	9.4	21.1
	0.3	20	18.9	10.0	22.8
(11) ГПД+ННХК	Без добавки	3	22	9.8	24.9
	0.2	7	20	8.3	21.8
	0.25	8	16.4	8.1	21.2
	0.30	9	17.2	8.1	20.5
	0.40	10	17.0	8.1	19.3
(12) СДБ	Без добавки	3	21	9.8	20.5
	0.15	7	18	8.1	19.2
	0.20	10	17.5	6.8	18.4
	0.25	17	14.5	4.2	16.1

Key:

1. SP brand
2. SP dose, in percent
3. Concrete-mix mobility, O.K., cm
4. Maximum compression strength (in MPa [not further identified] through)
5. 28 days of natural storage
6. 24 hours after heat-treatment
7. 28 days after heat-treatment
8. NIL-10
9. S-3
10. KOD-S + NN
11. GPD + NNKhK
12. SDB
13. Without additive

The results of the experiment revealed that:

the S-3, NIL-10 and KOD-S combined with NN additives provided the best indicators in terms of plasticizing action (from three to 20-22 cm O.K.) without changing the strength indicators of heavy concretes to different degrees;

the GPD + NNKhK additive demonstrated a weak plasticizing action (7-10 cm O.K.) in our experiments;

a significant increase in mobility (from three to 17 cm O.K.) was characteristic of the traditional SDB plasticizer additive, but the strength of the concrete decreased appreciably when the dose was increased from 0.15 to 0.25 percent (Table 2);

the KOD-S + NN additive provided more stable strength results at increased concrete-mix doses than did the other additives studied.

An evaluation was made of the economic effectiveness of using KOD-S for inside walls produced using magazine technology. It was established that use of the KOD-S plasticizer is economically justified both for the purpose of simplifying pouring equipment when changing over to casting technology and for the purpose of saving cement.

In spite of the fact that it is economically most effective to use KOD-S for the purpose of reducing cement expenditures, we consider the most efficient area of its application to be in obtaining highly mobile non-stratifying mixtures, which would provide an opportunity to eliminate either partially or fully noise and vibration and, as a result, to improve working conditions.

Thus, use of the new, highly effective plasticizing additives, the superplasticizers which facilitate a sharp improvement in concrete-mix placeability without increasing cement expenditure, is one feasible way of radically improving the technology of manufacturing reinforced concrete items.

A comparative evaluation made of domestic superplasticizers for concrete mixes showed that the most effective superplasticizers are the 10-03, S-3, NIL-10 and KOD-S additives, of which only the S-3 superplasticizer is currently being produced on a commercial scale. We should note the promise of using KOD-S which, along with its high technological effectiveness, is comparatively low in cost and plentiful. Moreover, this plasticizing additive is non-toxic, is not harmful to the environment and is distinguished by its ease of manufacture.

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